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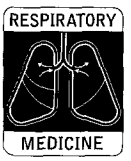

Original Articles

Screening patients in general practice with COPD for long term domiciliary oxygen requirement using pulse oximetry

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Epidemiological data suggest long term oxygen therapy (LTOT) delivered by oxygen concentrators in patients with severe hypoxic chronic obstructive pulmonary disease (COPD) is under-prescribed by General Practitioners (GPs) in England and Wales. One reason for this may be the unavailability to GPs of a measure of arterial oxygenation needed to fulfil the defined prescription criteria. Provision of a non-invasive measure of oxygenation may improve detection of hypoxic subjects and increase appropriate prescribing.

This study aimed to evaluate pulse oximetry in a general practice setting and to screen for severe undetected hypoxaemia fulfilling the LTOT prescription criteria in patients with COPD.

All COPD patients attending surgery in two practices were screened with oximeters for hypoxaemia. Those with an oxygen saturation of $\leq 92\%$ were referred to hospital for formal arterial blood gas analysis and an oxygen concentrator assessment. GPs were asked to evaluate their experience in the ease of use and application of oximetry. The number of patients receiving oxygen by concentrator before the study was compared with the national rate and the number after the study with the estimated need suggested by epidemiological studies.

Over a 12-month period a total of 114 patients were screened in the two practices with a combined list size of 15 742. Thirteen patients had saturations of $\leq 92\%$. Two refused and 11 underwent formal arterial gas analysis. Three had PaO_2 <7·3 kPa and new prescriptions for oxygen concentrators were made in these previously unsuspected severely hypoxaemic subjects as a result. One other hypoxaemic subject was referred and found to have another treatable medical condition. The initial prevalence of concentrator prescription (0·013% CI 0·003, 0·047) was similar to the national rate (0·024%) and the prevalence observed after screening (0·031%, CI 0·013, 0·073) fell within the lower suggested prescription need of previous epidemiological data (0·02–0·10%). All practitioners found the oximeters simple to use and helpful in assisting with assessment of the severity of their patients' condition.

Oximetry provides a readily usable non-invasive method of screening and when applied to all COPD patients seen in general practice can reveal those fulfilling the criteria for long term oxygen who would otherwise not be identified as needing this treatment.

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Introduction

Oxygen therapy for domiciliary use in the management of chronic obstructive pulmonary disease (COPD) in England and Wales is prescribed as either long term oxygen therapy (LTOT) delivered via an oxygen concentrator to improve life expectancy or short burst oxygen via cylinders for palliative relief of breathlessness. LTOT prescribed for home use and given for more than 15 h each day is proven to increase life expectancy in patients with COPD with severe hypoxia (1,2). This therapy is recommended in the Drugs Tariff (3) where specific criteria for its use are described. The patient must have spirometrically proven COPD with arterial PaO_2 <7·3 kPa, with the subject having received full and appropriate bronchodilator therapy. Statistics from the Department of Health (4) suggest a relative under-prescription of this mode of treatment compared with projected prescribing from epidemiological studies (5,6) and comparisons with continental neighbours (7).

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In England and Wales oxygen concentrators can only be prescribed by General Practitioners who themselves are unlikely to have direct access to the arterial blood gas measurements needed before the strict prescribing criteria for LTOT are met. Recommendation for LTOT is usually from a hospital physician but is dependent upon appropriate referral from primary care. The difficulty in selecting such patients on clinical grounds alone may be a contributing factor to the under-prescription of concentrators in England and Wales. The detection of cyanosis as a clinical sign is unreliable and difficult and a previous study in a specialist chest clinic revealed that reliance upon patient symptoms and clinical suspicion may be misleading as a guide to fulfilling the criteria for LTOT (8).

We hypothesized that provision to General Practitioners of a simple non-invasive method of assessing oxygen with a pulse oximeter might detect previously unsuspected cases of severe hypoxaemia in a primary care practice population.

This study received ethical approval from the committees of Redbridge and Waltham Forest and North Essex Health Authorities.

Methods

Two local general practices, Southdene, South Woodford, London, and Forest Surgery, Loughton, Essex, both within the referral area of Whipps Cross Hospital agreed to participate in a joint project over a 12-month period to assess the value of pulse oximetry in the detection of previously unsuspected severe hypoxaemia in subjects with COPD.

The Southdene practice with three principals had a list size of 6800 at the start of the study. During the 12 months 661 new registrations were made whilst 757 left the list. Forest surgery with four principals had 8942 registered patients with 981 new and 379 deleted registrations during the study year. Both are geographically suburban without areas of particular social deprivation. The study ran from October 1994 to September 1995.

The Minolta pulseox-7 (Minolta, Osaka, Japan), cost *c.* £1850, was chosen for this study. It has the advantage of relatively light weight and portability and has been validated as a screening tool for detection of hypoxaemia previously (8). The oximeter has a fairly simple set-up procedure. The machine is plugged into the mains, although a battery option is available, switched on and a visual light source on the finger probe allows the operator to position the lightwave sensor over the appropriate portion of the finger-nail bed. The oximeter display provides a measure of the signal strength, the pulse rate and the arterial oxygen saturation (SaO_2).

Oximetry recording was standardized as follows. All operators received a brief theory and practical training session in pulse oximetry. Each measurement was commenced as the patient sat down for their consultation. A brief explanation was given by the GP. The finger probe was placed appropriately over the nail bed and the machine activated. A check for a strong pulse was made and the probe repositioned if necessary. The oxygen saturation was noted after a stable reading ($\pm 1\%$) was observed over a 60-s period. The saturation result and the age and sex of the patient were recorded with the date on a research record sheet. Southdene practice was provided with two oximeters for three principals and Forest shared three between four principals.

All patients with a clinical diagnosis of COPD attending surgery or who received a home visit within the last 12-month period of the study underwent pulse oximetry administered by one of the GPs or a practice nurse. The diagnosis of COPD was made on clinical grounds by individual practitioners but included at least a significant smoking history with symptoms of progressive breathlessness.

All patients with an oxygen saturation of $\leq 92\%$ were asked to return for a further check when recovered from their current illness if acutely unwell with an exacerbation of COPD. Those with a second confirmed low reading or those with an initial low reading who were clinically stable were referred to the hospital for formal arterial blood gas analysis and spirometry. This was performed in the medical day unit by medical staff in accordance with a protocol used to determine the optimum oxygen requirement for LTOT. Thus an initial arterial blood sample was taken from the radial or brachial artery using a heparinized syringe and analysed using the ABL 3 (Radiometer, Copenhagen, Denmark) blood gas machine. If the PaO_2 was above 7·3 kPa no further tests were performed. If the PaO_2 was below this level further tests were undertaken inspiring oxygen delivered at 1 l min^{-1}) by nasal cannulae from an MC44 oxygen concentrator (De Vilbiss Healthcare, Heston, U.K.) increasing by 1 l increments every 30 min (range usually 1–3 l min^{-1}) until a PaO_2 over 8 kPa was attained with the minimal increase in the PaO_2. Spirometry was performed using a Vitalograph alpha spirometer (Vitalograph Buckingham, U.K.). The best FEV_1 and FVC readings were taken independently from three technically satisfactory forced expiratory manoeuvres. Patients who satisfied the criteria for LTOT were referred back to their GP with appropriate advice on flow rate, method of delivery and usage time.

The prevalence of patients receiving oxygen for concentrators at the beginning of the study was compared with national figures. The prescription prevalence at the completion of screening was compared with the epidemiological estimates of need (5,6).

Each principal was questioned at completion of the study about ease and acceptability of use of the oximeter, and possible future applications in a general practice setting.

Results

Data collected from the two practices has been combined to allow statistical analysis. Between practice comparisons were deemed to have insufficient statistical power. A total of 114 patients with COPD were screened during the year. Thirteen subjects had an SaO_2 $\leq 92\%$ (range 81–91%, median 90%). Two refused further investigation and 11 were referred to hospital for arterial blood gas estimation. Three patients fulfilled the criteria for LTOT and were

TABLE 1. Spirometric and arterial blood gas values, age and sex of subjects screened with $SaO_2 \leq 92\%$

Sex	Age (years)	FEV_1 (1)	FEV_1 (% pred)	FVC (1)	FVC (% pred)	SaO_2 (%)	PaO_2 (kPa)	$PaCO_2$ (kPa)
F	65	0·37	17	1·33	52	89	8·03	5·84
M	74	0·71	30	1·52	49	87	7·12	5·99
M	66	1·55	74	2·17	80	92	9·83	4·76
M	71	0·8	31	1·4	38	88	7·20	6·00
M	74	0·6	25	1·43	34	91	8·49	5·47
M	76	0·61	22	1·04	28	90	8·36	5·35
M	60	0·58	21	1·54	43	92	8·94	5·30
M	67	1·57	46	3·06	69	89	8·20	5·01
M	59	0·49	14	1·55	36	86	6·86	6·28
M	79	0·78	29	1·68	48	91	9·05	5·21
M	64	1·09	37	2·40	62	92	9·33	4·83

subsequently prescribed this treatment by their GPs on the advice of a hospital respiratory physician. Spirometric and arterial blood gas data on these 11 patients are given in Table 1. There were 10 males, the summary mean and standard deviation values for the data were as follows: age 68·6 years (6·3), FEV_1 0·801 (0·41), FEV_1 %pred 32% (16), FVC 1·741 (0·55), FVC %pred 50% (15), SaO_2 90% (2), PaO_2 8·32 kPa (0·91), $PaCO_2$ 5·46 kPa (0·41). One further patient with a low screening SaO_2 was referred to hospital and found to be suffering from bronchiolitis obliterans organizing pneumonia.

The two practices had two patients with COPD receiving oxygen from concentrators prior to the study and five in all at completion. Comparison between the initial prevalence of concentrator prescriptions in the two practices (2:15742) with Department of Health figures for 1995 (4,9) (12739:51 439 000) gave a prevalence of 0·0127% (95% CI 0·003%, 0·047%) locally compared with 0·024% for England and Wales overall. A similar comparison between the prevalence of patients receiving concentrator prescriptions at the end of the study (5: 16318) compared with epidemiological estimates of the requirement for the population of England and Wales made in 1983 (5,6) (10–50 000: 49 634 000) produced local practice figures of 0·03064% (CI 0·013%, 0·073%) compared with the range of national estimates of need of 0·02–0·10%, i.e. falling within the lower end of this range.

All principles found the oximeter easy to use and acceptable given the time constraints of the surgery consultation period. Principles commented however that to be of use the oximeter had to be in the consulting room. Searching other rooms for the equipment put unacceptable time pressure on the consultation period. All patients found the measurement acceptable with no adverse comments. Many patients thought the technology within the surgery impressive. When considering future applications in general practice participants felt that it would be useful in assessing severity of hypoxaemic in asthmatics, COPD, and heart failure patients, although reservations were expressed abut interpretation of data in complex scenarios. Financial cost of the equipment was thought to be high and a likely limiting factor in use even if sufficient application were found.

Discussion

This study indicates that COPD patients with unsuspected severe hypoxaemia may be prevalent in primary care and that screening oximetry offers one method of detecting patients who might benefit from LTOT. There are however a number of other factors to consider before such a policy could be recommended. The study itself has limitations. Although a population of over 15 500 was included in this research it represents but a tiny fraction of those within England and Wales and may not be representative. In particular both practices are suburban and fairly affluent. They could not claim to represent inner city populations from which much previous epidemiological data has been collected. It is likely however that smoking rates and therefore prevalence of COPD and resultant hypoxaemia would be higher in inner city practices and the potential for detection of severe hypoxaemia even greater. The prevalence of concentrator prescriptions locally was however statistically similar to the overall figures of England and Wales which includes concentrators prescribed for all medical indications. The prevalence of prescriptions at the end of the study fell within the lower estimates from epidemiological studies but outside the highest estimates for concentrator need. Furthermore, the numbers of subjects with severe hypoxaemia and LTOT requirement detected in this study are tiny and extrapolating conclusions from such a small group is potentially misleading. It is true to say however that in the practices studied there were patients who might benefit from LTOT who were not receiving this treatment before the study but who are now as a result of screening with oximetry.

The practicality of providing general practices with oximeters is a different issue. The cost is significant but cheaper oximeters than the Minolta are available from about £1000. Although GPs felt that one machine per consulting room was necessary to facilitate the logistics of the

consultation there are other practical options. For example a single oximeter could be available to the practice nurse who could screen all patients attending a COPD/asthma clinic or selectively perform oximetry at the request of a GP.

There are some practical issues around the setting in which oximetry is performed that might make this situation more advisable. Firstly some subjects with COPD lower their oxygen saturation simply on walking (10,11) and this may take 1 or 2 min to recover. An oximetry reading taken at the beginning of a consultation for practical purposes of speed and convenience might overestimate the prevalence of resting hypoxaemia. Secondly an unreliable saturation figure may be produced if the pulse signal strength is poor. This may occur because of incorrect positioning of the finger probe or because the pulse is weak e.g. low output heart failure, vasoconstriction from cold, or for other technical reasons e.g. wearing of nail varnish, strongly pigmented skin (12). All of these situations require the operator to have sufficient time and experience to allow for these potential errors and to correct them.

A further concern would be in the over-interpretation of oximetry in other clinical settings. For instance reliance on oximetry alone in assessing acute deterioration in subjects with COPD receiving oxygen is notoriously hazardous as CO_2 retention may be ignored in the presence of apparently satisfactory SaO_2. Reliance on oximetry alone in the prescription of oxygen therapy to such patients is fraught with hazard. Oximetry may also be used as part of the assessment of other acute medical problems e.g. asthma or pneumonia but might lead to inappropriate management decisions if used out of context. Full training in the interpretation of oximetry would be necessary before general use of oximeters could be recommended.

Spirometers were not available in either of these practices as was the case in most U.K. GP surgeries at the time of the study. Since the publication of the British Thoracic Society guidelines on the management of COPD (13) which encourages the use of spirometry in general practice this situation may soon change. Certainly spirometry is essential in confirming the diagnosis of COPD by measuring the presence of airflow obstruction. It must also be recognised however that spirometry alone has a limited role in screening for severe hypoxia in this patient group (14). An alternative approach would be to provide open access to oximetry for general practice patients but in a hospital setting within a department of respiratory medicine. Oximetry could then be combined with an open access spirometry service to confirm the COPD diagnosis and to assist in interpretation of data by specialist respiratory physicians. Some patients with COPD may feel the journey to hospital a daunting prospect however as illustrated by the two refusals in this study.

In conclusion we found that patients with unsuspected severe hypoxaemia are present in the primary care practice population and can be detected using oximetry as a screening tool. The equipment is simple to use but relatively expensive and may have limited overall application in general practice. The setting in which screening should take place requires further examination. Referral to a specialist respiratory unit for full assessment would still be advisable to allow confirmation of the recommended arterial blood gas criteria and to determine the oxygen flow rate advisable prior to prescription of LTOT.

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